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3126B
MARINE ENGINES
Maintenance Intervals

Excerpted from Operation & Maintenance Manual (SEBU7242-05-01)

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CATERPILLAR

i02507477

Maintenance Interval Schedule (High Performance)

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Battery - Replace 63
Battery or Battery Cable - Disconnect 64
Engine Oil Level Gauge - Calibrate 77
Engine Storage Procedure - Check 80
Fuel System - Prime 80

Daily

Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect 64
Cooling System Coolant Level - Check 71
Engine Air Cleaner Service Indicator - Inspect 75
Engine Oil Level - Check 76
Fuel System Primary Filter/Water Separator - Drain 82
Fuel System Water Separator - Drain 83
Marine Transmission Oil Level - Check 86
Walk-Around Inspection 91

Every 1400 L (375 US gal) of Fuel or 50 Service Hours

Zinc Rods - Inspect/Replace 92

Every 5700 L (1500 US gal) of Fuel or 150 Service Hours for Engines Used in Severe Applications

Engine Oil and Filter - Change 78

First 5700 L (1500 US gal) of Fuel or 200 Service Hours

Engine Valve Lash - Inspect/Adjust 80

PM Level 1 - Every 5700 L (1500 US gal) of Fuel or 200 Service Hours or 1 Year

Aftercooler Condensate Drain Valve - Inspect/Clean 61
Alternator Belt - Inspect/Adjust/Replace 62
Auxiliary Water Pump - Inspect 63
Battery Electrolyte Level - Check 63
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 72
Engine Air Cleaner Element - Clean/Replace 74
Engine Crankcase Breather - Clean 76
Engine Oil Sample - Obtain 78
Engine Oil and Filter - Change 78
Fuel System Primary Filter (Water Separator) Element - Replace 82
Fuel System Secondary Filter - Replace 83
Fuel Tank Water and Sediment - Drain 84
Hoses and Clamps - Inspect/Replace 85

Every 17 000 L (4500 US gal) of Fuel or 600 Service Hours

Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace 65
Turbocharger - Inspect/Clean 90

PM Level 2 - Every 28 400 L (7500 US gal) of Fuel or 1000 Service Hours or 2 Years

Aftercooler Core - Clean/Test 61
Heat Exchanger - Inspect 85

Every 85 200 L (22 500 US gal) of Fuel or 3000 Service Hours or 3 Years

Cooling System Coolant (DEAC) - Change 66
Cooling System Coolant Extender (ELC) - Add 70

PM Level 3 - Every 56 800 L (15 000 US gal) of Fuel or 2000 Service Hours

Alternator - Inspect 62
Cooling System Water Temperature Regulator - Replace 73
Crankshaft Vibration Damper - Inspect 74
Engine Mounts - Inspect 76
Engine Valve Lash - Inspect/Adjust 80
Starting Motor - Inspect 89
Water Pump - Inspect 91

Every 170 400 L (45 000 US gal) of Fuel or 6000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change 68

Overhaul

Overhaul Considerations 86

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Maintenance Interval Schedule (Commercial Ratings)

SMCS Code: 1000; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Battery - Replace 63
Battery or Battery Cable - Disconnect 64
Engine Oil Level Gauge - Calibrate 77
Engine Storage Procedure - Check 80
Fuel System - Prime 80

Daily

Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect 64
Cooling System Coolant Level - Check 71
Engine Air Cleaner Service Indicator - Inspect 75
Engine Oil Level - Check 76
Fuel System Primary Filter/Water Separator - Drain 82
Fuel System Water Separator - Drain 83
Marine Transmission Oil Level - Check 86
Walk-Around Inspection 91

Every 1400 L (375 US gal) of Fuel or 50 Service Hours

Zinc Rods - Inspect/Replace 92

First 5700 L (1500 US gal) of Fuel or 200 Service Hours

Engine Valve Lash - Inspect/Adjust 80

PM Level 1 - Every 5700 L (1500 US gal) of Fuel or 200 Service Hours or 1 Year

Aftercooler Condensate Drain Valve - Inspect/Clean 61
Alternator Belt - Inspect/Adjust/Replace 62
Auxiliary Water Pump - Inspect 63
Battery Electrolyte Level - Check 63
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 72
Fuel Tank Water and Sediment - Drain 84
Hoses and Clamps - Inspect/Replace 85

Every 17 000 L (4500 US gal) of Fuel or 500 Service Hours

Engine Air Cleaner Element - Clean/Replace 74
Engine Crankcase Breather - Clean 76
Engine Oil Sample - Obtain 78
Engine Oil and Filter - Change 78
Fuel System Primary Filter (Water Separator) Element - Replace 82
Fuel System Secondary Filter - Replace 83

Every 17 000 L (4500 US gal) of Fuel or 600 Service Hours

Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace 65
Turbocharger - Inspect/Clean 90

PM Level 2 - Every 28 400 L (7500 US gal) of Fuel or 1000 Service Hours or 2 Years

Aftercooler Core - Clean/Test 61
Heat Exchanger - Inspect 85

Every 85 200 L (22 500 US gal) of Fuel or 3000 Service Hours or 3 Years

Cooling System Coolant (DEAC) - Change 66
Cooling System Coolant Extender (ELC) - Add 70

PM Level 3 - Every 56 800 L (15 000 US gal) of Fuel or 2000 Service Hours

Alternator - Inspect 62
Cooling System Water Temperature Regulator - Replace 73
Crankshaft Vibration Damper - Inspect 74
Engine Mounts - Inspect 76
Engine Valve Lash - Inspect/Adjust 80
Starting Motor - Inspect 89
Water Pump - Inspect 91

Every 170 400 L (45 000 US gal) of Fuel or 6000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change 68

Overhaul

Overhaul Considerations 86

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Aftercooler Condensate Drain Valve - Inspect/Clean

SMCS Code: 1063-042-DN, VL

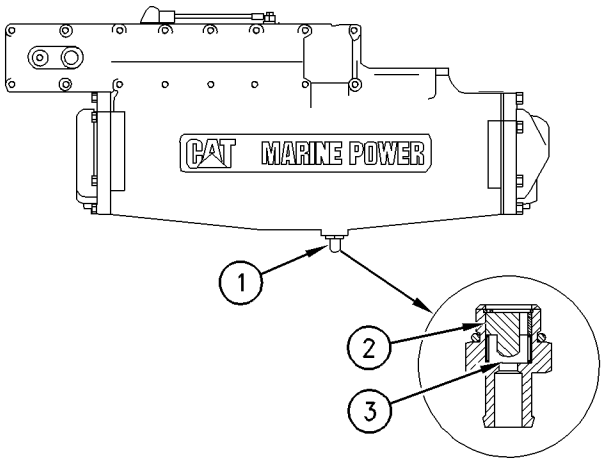

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Illustration 17

(1) Valve
(2) Plunger
(3) Valve seat

The boost pressure forces plunger (2) to move down on valve seat (3). The plunger must close against the seat at a pressure of 27.5 kPa (4 psi). When the engine is stopped, the absence of boost pressure allows the plunger to rise to the open position. This allows the condensation from the aftercooler to drain out.

The plunger must be able to move freely in order to close the system when the engine is running. The plunger must be able to move freely in order to allow condensation to drain from the aftercooler when the engine is stopped. Residue from normal engine operation could cause the plunger to stick.

1. Remove valve (1) from the housing. Check the valve in order to determine if plunger (2) moves freely. If the plunger does not move easily, clean the valve with solvent.

2. Reassemble the aftercooler condensate drain valve. Refer to the Specifications, SENR3130, “Torque Specifications”.

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Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081

1. Remove the core. Refer to the Service Manual for the procedure.

2. Turn the aftercooler core upside-down in order to remove debris.

NOTICE
Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

3. Back flush the core with cleaner.

   Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 12 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 12

Hydrosolv Liquid Cleaners[1]		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.

4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.

5. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.

8. Install the core. Refer to the Service Manual for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

i00072207

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required. Refer to the Service Manual.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

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Alternator Belt - Inspect/Adjust/Replace

SMCS Code: 1357-036; 1357-510

Inspection

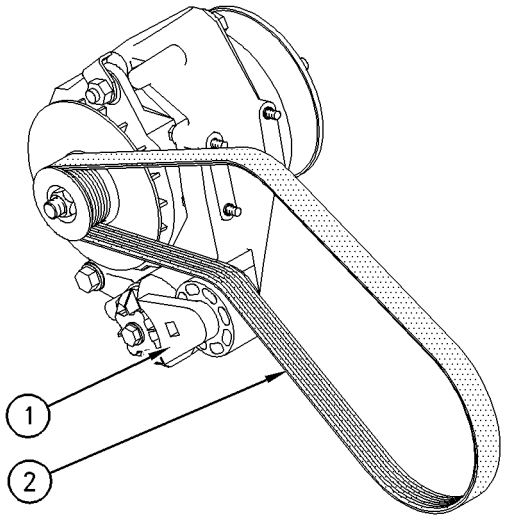

Illustration 18 g00700096

(1) Belt tensioner
(2) Serpentine belt

Remove the belt guard.

Belt tension should be visually checked between the first 20 to 40 hours of engine operation.

After the initial check, the belt tension should be checked at Every 200 Service Hours or 1 Year.

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

If new belts are installed, check the belt tension again after 30 minutes of engine operation at the rated rpm.

Inspect the belt tensioner for unusual noise, excessive looseness and/or shaking of the bearings.

Install the belt guard.

i01059376

Auxiliary Water Pump - Inspect

SMCS Code: 1371-040

Impellers require periodic inspection and seals require periodic inspection. Impellers have a service life that is limited. The service life depends on the engine operating conditions.

Inspect the components of the pump more frequently when the pump is exposed to debris, sand, or other abrasive materials. Inspect the components if the pump is operating at a differential pressure of more than 103 kPa (15 psi).

Check the following components for wear and check the following components for damage:

- Cam
- Impeller
- Seals
- Wear plate

If wear is found or if damage is found, replace the components which are worn or replace the components which are damaged. Use the proper repair kit for the pump. Refer to the Disassembly and Assembly for more information on servicing the auxiliary water pump.

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Battery - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
8. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

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Battery Electrolyte Level - Check

SMCS Code: 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

   If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

   Clean the battery case with one of the following cleaning solutions:

   - A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
   - A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

   Thoroughly rinse the battery case with clean water.

   Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

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Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.

2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.

3. Tape the leads in order to help prevent accidental starting.

4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

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Closed Crankcase Ventilation (CCV) Filter Service Indicator - Inspect

SMCS Code: 1317-040-FI

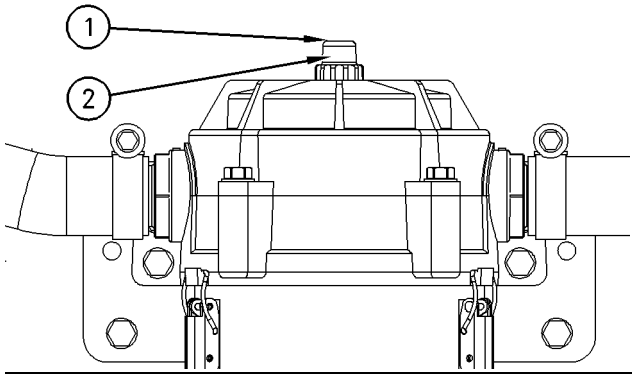

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Illustration 19

(1) Plastic cover
(2) Service indicator

The Closed Crankcase Ventilation system (CCV) is equipped with a service indicator. If the fumes disposal filter becomes plugged prior to the normal service interval, increased restriction of the filter will cause the crankcase pressure to become positive. When the pressure continues to rise, the service indicator will show through the plastic cover. The service indicator indicates the need for the fumes disposal filter to be changed. Refer to the Operation and Maintenance Manual, “Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace” topic for more information.

Note: Check the service indicator when the engine is running at low idle.

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Closed Crankcase Ventilation (CCV) Fumes Disposal Filter - Replace

SMCS Code: 1317-510-FI

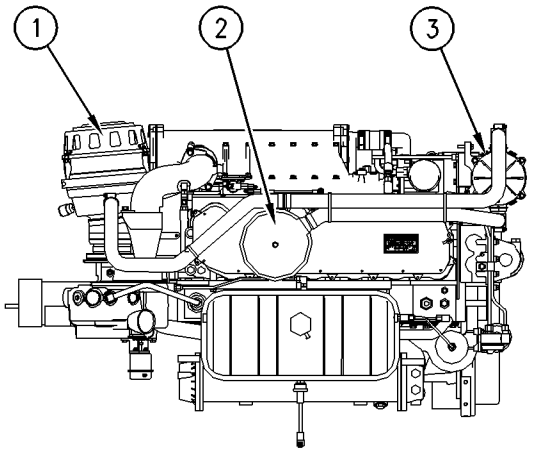


Illustration 20 g00744007

(1) Air cleaner
(2) Crankcase breather
(3) Fumes disposal filter

The Closed Crankcase Ventilation system (CCV) requires the replacement of the fumes disposal filter. The service interval of the Closed Crankcase Ventilation system (CCV) will be affected by the following items:

- Engine load
- Soot concentration
- Condition of the engine

The Closed Crankcase Ventilation system (CCV) is equipped with a service indicator. If the fumes disposal filter becomes plugged prior to the normal service interval, increased restriction of the filter will cause the vacuum to become positive. When the pressure continues to rise, the service indicator will show through the cap. The service indicator indicates the need for the fumes disposal filter to be changed. Reset the service indicator by using the following procedure:

Resetting the Service Indicator

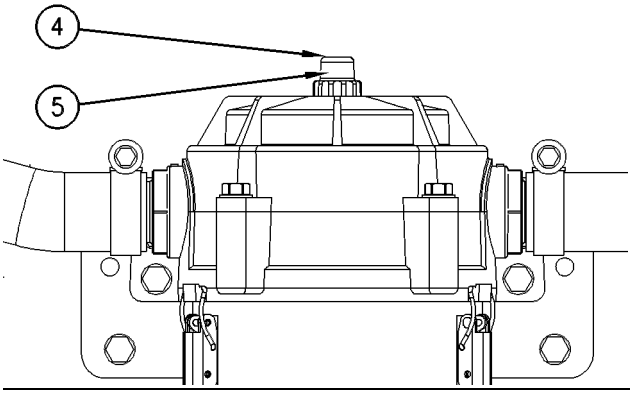


Illustration 21 g00585674

1. Remove plastic cover (4).
2. Push down on service indicator (5).
3. Replace cover (4).
4. Replace the fumes disposal filter by using the following procedure:

Replacing the Fumes Disposal Filter

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Note: When possible, perform the maintenance while the engine is off.

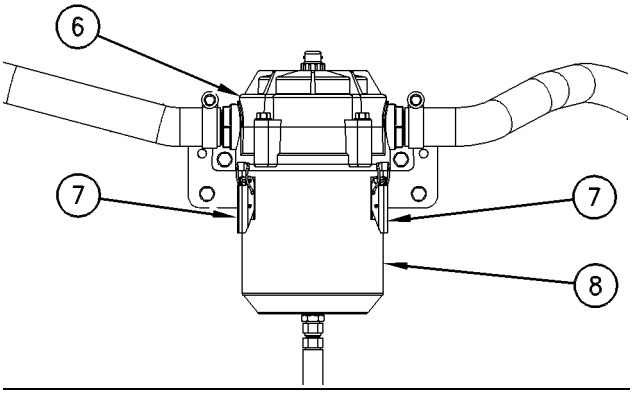


Illustration 22 g00585616

1. Release latches (7) that hold the canister to filter base assembly (6).

Note: Removal of canister (8) may be difficult while the engine is operating. The canister has negative air pressure while the engine is operating. This creates a vacuum.

2. Lower canister (8) in order to expose the element. There may be oil in the bottom of the canister. Avoid spilling the oil.

3. Remove the filter element by pulling down.

4. Ensure that the O-ring is installed on the top of the new element. Place the new element in the correct position on filter base assembly (6).

5. Ensure that the O-ring is installed on the lip which is located at the top of canister (8). Install canister (8) and align the canister with the boss on filter base assembly (6).

6. Clamp latches (7) in the closed position.

7. Dispose of the used element properly.

i01081100

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming of the coolant
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE
Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

   Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

Cooling Systems with Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

Fill

Refer to the Operation and Maintenance Manual, “Coolant Specifications” topic for information regarding acceptable water, coolant/antifreeze, and supplemental coolant additive requirements. Refer to the Operation and Maintenance Manual, “Refill Capacities” topic for the capacity of the engine’s system.

Engines that are Equipped with a Coolant Recovery Tank

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Add coolant to the cooling system until the cooling system is full.

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

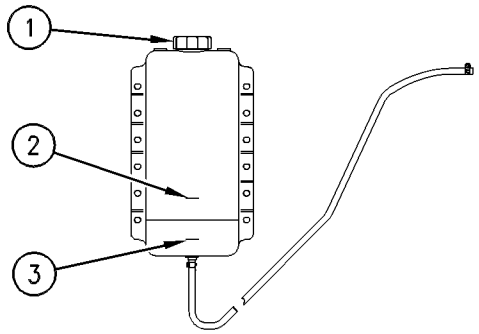


Illustration 23 g00103638

(1) Recovery tank filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

5. Loosen the cap for the coolant recovery tank slowly in order to relieve any pressure. Remove the cap for the coolant recovery tank.

6. Pour coolant into the coolant recovery tank until the coolant reaches the “COLD FULL” mark. DO NOT fill the coolant recovery tank above the “COLD FULL” mark.

7. Clean the cap for the coolant recovery tank. Install the cap for the coolant recovery tank.

8. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Engines that are Not Equipped with a Coolant Recovery Tank

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start the engine and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i01083041

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming of the coolant

- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

   Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with clean water. Install the cooling system filler cap.
4. Start the engine and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual for your particular engine for more specific information on the proper torques. Refer to the Specifications, SENR3130, “Torque Specifications” for more general information on the proper torques.

Fill

Engines that are Equipped with a Coolant Recovery Tank

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Place the transmission in neutral. Start the engine and operate the engine at low idle. Increase the engine rpm to 1500 rpm. Operate the engine at 1500 rpm for one minute in order to purge air from the cavities of the engine block. Stop the engine.
3. Pour more ELC into the cooling system until the cooling system is full.

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

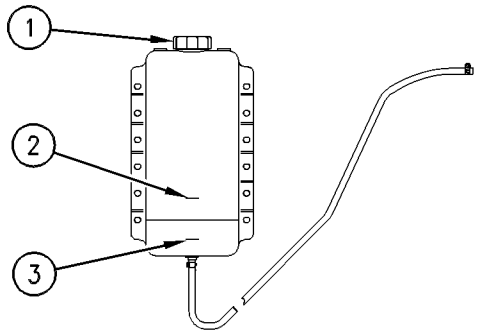


Illustration 24 g00103638

(1) Recovery tank filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

5. Loosen the cap for the coolant recovery tank slowly in order to relieve any pressure. Remove the cap for the coolant recovery tank.

6. Pour Extended Life Coolant (ELC) into the coolant recovery tank until the coolant reaches the “COLD FULL” mark. DO NOT fill the coolant recovery tank above the “COLD FULL” mark.

7. Clean the cap for the coolant recovery tank. Install the cap for the coolant recovery tank.

8. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Engines that are NOT Equipped with a Coolant Recovery Tank

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Place the transmission in neutral. Start the engine and operate the engine at low idle. Increase the engine rpm to 1500 rpm. Operate the engine at 1500 rpm for one minute in order to purge air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02482066

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender only needs to be added once.

NOTICE
Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.

2. It may be necessary to drain enough coolant from the cooling system in order to add the Cat ELC Extender.

3. Add Cat ELC Extender according to the requirements for your engine’s cooling system capacity. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” article for more information.

4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

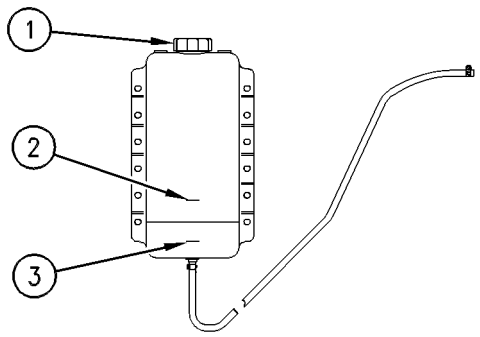
i02456586

Cooling System Coolant Level - Check

SMCS Code: 1395-082

Check the coolant level when the engine is stopped and cool.

Engines That Are Equipped with a Coolant Recovery Tank



g00103638

Illustration 25

(1) Filler cap
(2) “COLD FULL” mark
(3) “LOW ADD” mark

1. Observe the coolant level in the coolant recovery tank. Maintain the coolant level to “COLD FULL” mark (2) on the coolant recovery tank.

2. Loosen filler cap (1) slowly in order to relieve any pressure. Remove the filler cap.

3. Pour the proper coolant mixture into the tank. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for information about coolants. Do not fill the coolant recovery tank above “COLD FULL” mark (2).

4. Clean filler cap (1) and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

Note: The coolant will expand as the coolant heats up during normal engine operation. The additional volume will be forced into the coolant recovery tank during engine operation. When the engine is stopped and cool, the coolant will return to the engine.

Engines That Are Not Equipped with a Coolant Recovery Tank

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

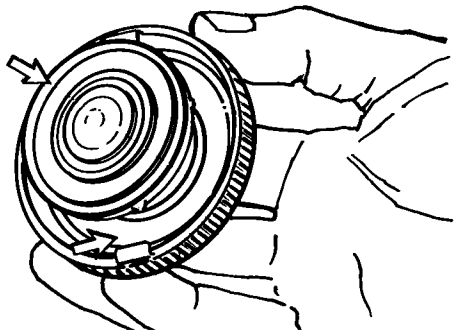


Illustration 26 g00103639

Typical filler cap gaskets

3. Clean the cooling system filler cap and inspect the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i02456600

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

⚠ WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.

Note: Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

Test for SCA Concentration

Coolant and SCA

NOTICE
Do not exceed the recommended six percent supplemental coolant additive concentration.

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information.

Water and SCA

NOTICE
Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for more information.

S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Level 2

This level coolant analysis is recommended when the engine is overhauled. Refer to this Operations and Maintenance Manual, “Overhaul Considerations” for further information.

Add the SCA, If Necessary

NOTICE
Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine’s heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
3. Add the proper amount of SCA. Refer to the Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engines Fluids Recommendations” for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i00912898

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i00072369

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

Removal and Installation

Refer to the Service Manual for the damper removal procedure and for the damper installation procedure.

Visconic Damper

The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration. Inspect the damper for evidence of dents, cracks or leaks of the fluid.

Replace the damper if the damper is dented, cracked or leaking. Refer to the Service Manual or consult your Caterpillar dealer for damper replacement.

i02053406

Engine Air Cleaner Element - Clean/Replace

SMCS Code: 1054-070; 1054-510

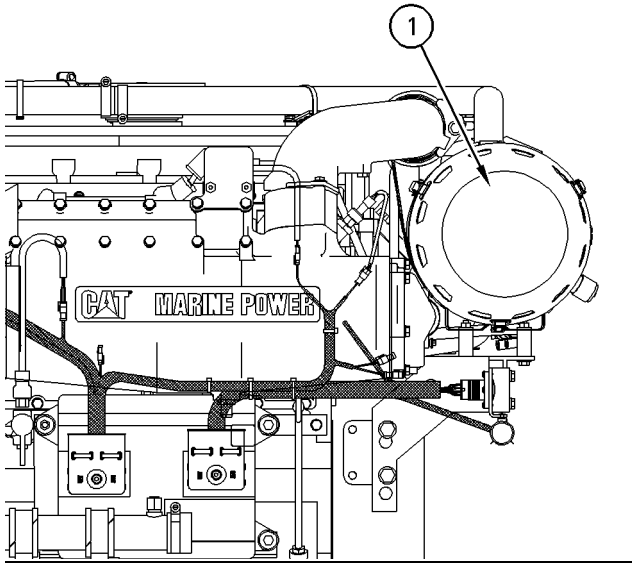


Illustration 27 g00743906

(1) Air cleaner element

Note: Use the 102-9720 Cleaning Kit in order to clean the air cleaner element. These products contain the detergent and oil that is made specifically for the maintenance of the air cleaner elements.

1. Remove air cleaner element (1). Tap the air cleaner element in order to dislodge dirt particles. Gently brush the air cleaner element with a soft bristle brush.

NOTICE
Do not use gasoline, steam, caustic or unapproved detergents, or parts cleaning solvents. Do not use high pressure water or air to clean the air cleaner element. Any of those liquids or methods can cause air cleaner element damage.

2. Spray air cleaner element (1) with the cleaning solution. Allow the air cleaner element to stand for 20 minutes.

3. Rinse air cleaner element (1) with low water pressure. The maximum water pressure for this procedure is 275 kPa (40 psi). Tap water is acceptable. Start to rinse the air cleaner element from the clean side (inside). Next, clean the dirty side (outside) in order to flush out dirt. Inspect the air cleaner element for tears and/or holes after the air cleaner element is cleaned. Do not reuse damaged air cleaner elements.

NOTICE
Do not use compressed air, open flame, or hot air to dry the air cleaner element. Excess heat shrinks cotton fiber, and compressed air may blow holes in the material. Allow the air cleaner element to air dry.

4. Shake excess water off air cleaner element (1), and allow the air cleaner element to air dry. Drying the air cleaner element in the sun speeds the process.

NOTICE
Do not use transmission fluid, engine oil, diesel fuel, or other lubricant to oil the air cleaner element. The air cleaner element can not function correctly if improper oil is used. Never operate an engine with a dry air cleaner element. The air cleaner element can not function correctly without oil. Always saturate the clean air cleaner element with the recommended oil.

5. The dry air cleaner element should be oiled before installation. Apply small amounts of oil across the top of each pleat. Allow the oil wick into the air cleaner element for 20 minutes. Oil any remaining “white” spots.

6. Inspect the housing and the clamp for air cleaner element (1). Replace the housing and the clamp, if necessary. Install the clean, oiled air cleaner element. Refer to Specifications, SENR3130, “Torque Specifications” for more information on the proper torques.

i01900118

Engine Air Cleaner Service Indicator - Inspect (If Equipped)

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner housing or in a remote location.

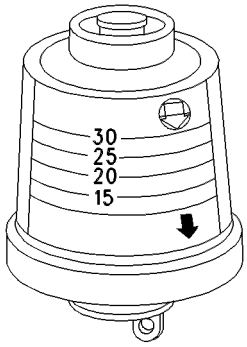


Illustration 28 g00103777
Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be plugged.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i02053400

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE
Perform this maintenance with the engine stopped.

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

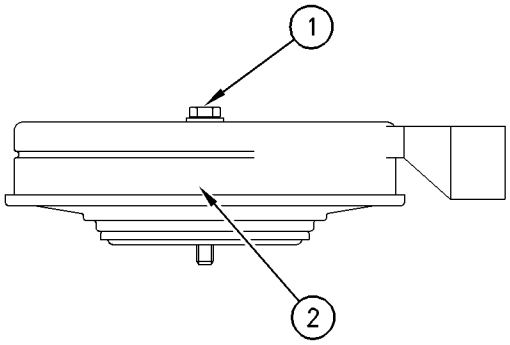


Illustration 29 g00638236

(1) Bolt
(2) Breather assembly

1. Loosen the hose clamp and remove the hose from breather assembly (2).
2. Loosen bolt (1). Remove breather assembly (2) and the seal.
3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
4. Install a breather element that is clean and dry. Install breather assembly (2) and the seal. Tighten bolt (1).
5. Install the hose. Install the hose clamp. Refer to Specifications, SENR3130, “Torque Specifications” for the proper torques.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, “Torque Specifications” for the recommended torques. Refer to the OEM recommendations for more information.

i01007363

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

Check the oil level after the engine has stopped. This maintenance procedure must be performed on a level surface.

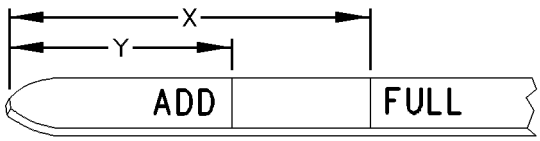


Illustration 30 g00110310

(Y) “ADD” mark
(X) “FULL” mark

1. Maintain the oil level between the “ADD” mark (Y) and the “FULL” mark (X) on the oil level gauge. Do not fill the crankcase above “FULL” mark (X).

NOTICE
Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil’s lubricating characteristics and could result in the loss of power.

2. Remove oil filler cap and add oil, if necessary. Clean the oil filler cap. Reinstall the oil filler cap.

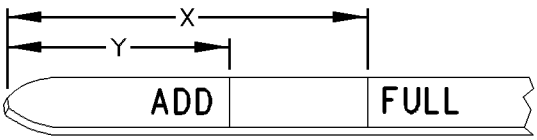
i01094856

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524

The engine is shipped with an engine oil level gauge that is not marked. The engine oil level gauge is not marked because the angle of installation can be different for each engine. The angle of installation will affect the “ADD” mark (Y) and the “FULL” mark (X) that is engraved on the engine oil level gauge.

The engine oil level gauge must be calibrated after the engine is installed in the vessel. Table 13 lists the corresponding “ADD” mark, “FULL” mark and the angle of installation. Use a marking pen in order to engrave “ADD” mark (Y) and “FULL” mark (X) on the engine oil level gauge according to the information in Table 13.



g00110310

Illustration 31

Oil Level Gauge

(Y) “ADD” mark
(X) “FULL” mark

Calibration of Oil Level Gauge

Table 13

Engine Oil Level Gauge		
Angle(1)	**“FULL” Mark (X)**	**“ADD” Mark (Y)**
10 degrees	125 mm (4.92 inch)	114 mm (4.49 inch)
9 degrees	124 mm (4.89 inch)	106 mm (4.17 inch)
8 degrees	122 mm (4.80 inch)	102 mm (4.02 inch)
7 degrees	120 mm (4.72 inch)	96 mm (3.78 inch)
6 degrees	115 mm (4.53 inch)	89 mm (3.50 inch)
5 degrees	110 mm (4.33 inch)	81 mm (3.19 inch)
4 degrees	101 mm (3.98 inch)	71 mm (2.80 inch)
3 degrees	94 mm (3.70 inch)	66 mm (2.60 inch)
2 degrees	90 mm (3.54 inch)	59 mm (2.32 inch)
1 degree	82 mm (3.23 inch)	52 mm (2.05 inch)
0 degrees	76 mm (2.99 inch)	46 mm (1.81 inch)
-1 degree	65 mm (2.56 inch)	39 mm (1.54 inch)
-2 degrees	59 mm (2.32 inch)	33 mm (1.30 inch)
-3 degrees	53 mm (2.09 inch)	26 mm (1.02 inch)
-4 degrees	46 mm (1.81 inch)	20 mm (0.79 inch)
-5 degrees	39 mm (1.54 inch)	12 mm (0.47 inch)

(1) The angle indicates the number of degrees that the front of the engine is raised. A negative angle indicates the number of degrees that the front of the engine is lowered.

Verifying the Calibration of the Oil Level Gauge

Caterpillar recommends verifying the calibration of the oil level gauge at the first oil change. Use the following procedure to verify the “FULL” mark on the oil level gauge:

Note: The vessel must be level in order to perform this procedure.

1. Operate the engine until normal operating temperature is achieved. Stop the engine. Remove one of the drain plugs for the engine crankcase. Allow the engine oil to drain.

2. Remove the used engine oil filter. Install the new engine oil filter. Install the crankcase drain plug and tighten the crankcase drain plug.

3. Add 25 L (26.5 qt) of the recommended oil grade and weight of engine oil to the crankcase.

Note: The engine may be equipped with auxiliary engine oil filters which require additional oil. Refer to the OEM specifications.

NOTICE
To help prevent crankshaft or bearing damage, crank engine to fill all filters before starting. Do not crank engine for more than 30 seconds.

NOTICE
Do not crank the engine for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking again.

Turbocharger (if equipped) damage can result, if the engine rpm is not kept low until the engine oil light/ gauge verifies the oil pressure is sufficient.

4. Start the engine. Ensure that the lubrication system and the new engine oil filter is filled. Inspect the lubrication system for leaks.

5. Stop the engine and allow the engine oil to drain into the engine crankcase for approximately ten minutes.

6. Check the engine oil level. If necessary, use a marking pen in order to correct the “FULL” mark (X).

i01935337

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM; 7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, “How To Take A Good Oil Sample”. Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i02107152

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed.

Replace the Oil Filter

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.
2. Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

   Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

   Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

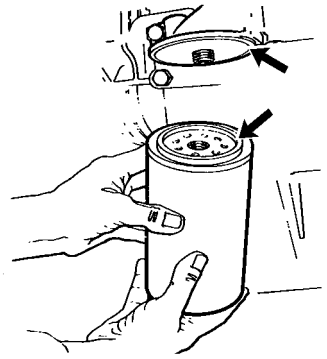


Illustration 32 g00103713
Typical filter mounting base and filter gasket

3. Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.
4. Apply clean engine oil to the new oil filter gasket.

NOTICE
Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer’s recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at “LOW IDLE” for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

i01430860

Engine Storage Procedure - Check

SMCS Code: 1000-535

Caterpillar requires all engines that are stored for more than 3 months to follow storage procedures and start-up procedures. These procedures provide maximum protection to internal engine components. Refer to Special Instruction, SEHS9031, “Storage Procedure For Caterpillar Products” for information on these procedures.

An extension of the oil change interval to 12 months is permitted if you follow the required procedures for storage and start-up. This extension is permitted if the following intervals in the Operation and Maintenance Manual, “Maintenance Interval Schedule” have not been reached:

- Operating hours
- Fuel consumption

i00869628

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE
Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

⚠ WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i02113137

Fuel System - Prime

SMCS Code: 1258-548

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Prime the fuel system in order to fill the fuel filter. Prime the fuel system in order to purge trapped air. The fuel system should be primed under the following conditions:

- Running out of fuel
- Storage
- Replacement of the fuel filter

Engines that are Equipped with a Fuel Priming Pump

NOTICE
Do not loosen the fuel lines at the fuel manifold. The fittings may be damaged and/or a loss of priming pressure may occur when the fuel lines are loosened.

1. Open the fuel priming pump and operate the fuel priming pump until a strong pressure is felt. This procedure will require considerable strokes. Lock the fuel priming pump.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

2. Promptly start the engine. If the engine runs rough, continue to operate the engine at low idle. Do not raise the engine rpm above an idle, until the engine operates smoothly.
3. If the engine does not start, open the fuel priming pump and repeat Steps 1 and 2 in order to start the engine.

Engines that are Not Equipped with a Fuel Priming Pump

If the engine is not equipped with a fuel priming pump, you can use the following procedures to prime the fuel system. These procedures will allow only filtered fuel to enter the fuel system.

Fuel Filter Bases that are Equipped with a Plug

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

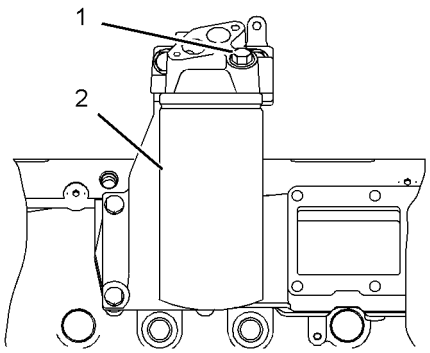


Illustration 33 g01076450

(1) Plug
(2) Fuel filter

1. Remove plug (1) in order to fill fuel filter (2). Ensure that air is able to vent from the fitting of the plug while the fuel filter is being filled. Clean up any spilled fuel immediately. Clean plug (1). Install plug (1).

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

2. Start the engine and operate the engine at low idle. Do not raise the engine speed above an idle, until the engine operates smoothly.

Fuel Filter Bases that are Not Equipped with a Plug

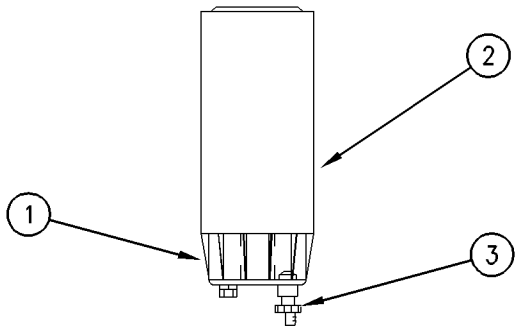
NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

1. Operate the starting motor. This will fill the fuel filter and the fuel lines with fuel.
2. Once the engine starts, operate the engine at low idle. Do not raise the engine speed above an idle, until the engine operates smoothly.

i01463757

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543



g00668636

Illustration 34

(1) Bowl
(2) Element
(3) Drain

Bowl (1) should be monitored daily for signs of water. If water is present, drain the water from the bowl.

1. Open drain (3). The drain is a self-ventilated drain. Catch the draining water in a suitable container. Dispose of the water properly.
2. Close drain (3).

NOTICE
The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

i02053433

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510-FQ; 1263-510-FQ

Water in the fuel can cause the engine to run rough. Water in the fuel may cause a electronic unit injector to fail. If the fuel has been contaminated with water, the element should be changed before the regularly scheduled interval.

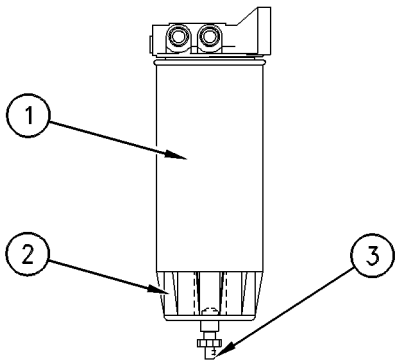
The primary filter/water separator also provides filtration in order to help extend the life of the secondary fuel filter. The element should be changed regularly. If a vacuum gauge is installed, the primary filter/water separator should be changed at 50 to 70 kPa (15 to 20 inches Hg).

Replace the Element

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

1. Close the main fuel supply valve.



g00104012

Illustration 35

Element (1), Bowl (2), and Drain (3)

2. Remove element (1) from the element mounting base while bowl (2) is attached.
3. Dispose of the contents of the filter. Remove bowl (2) from element (1). The bowl is reusable. Do not discard the bowl. Dispose of the used element.
4. Remove the O-ring from the gland of the bowl. Clean the following components:
   - Bowl
   - O-ring
   - Mounting base

   Inspect the O-ring for damage and for deterioration. Replace the O-ring, if necessary.
5. Lubricate the O-ring with clean diesel fuel.
6. Install bowl (2) on a new element. Tighten the bowl by hand. Do not use tools in order to tighten the bowl.

NOTICE
The primary filter/water separator may be prefilled with fuel to avoid rough running/stalling of the engine due to air. Do not fill the secondary filter with fuel before installation. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

7. Lubricate the top seal of element (1) with clean diesel fuel. The element may be filled with fuel at this time. Install the new element on the mounting base. Tighten the element by hand.

NOTICE
The water separator is under suction during normal engine operation. Ensure that the vent plug is tightened securely to help prevent air from entering the fuel system.

8. Open the main fuel supply valve.

9. Start the engine and check for leaks. Run the engine for one minute. Stop the engine and check for leaks again.

   Detecting leaks is difficult while the engine is running. The primary filter/water separator is under suction. A leak will allow air to enter the fuel. The air in the fuel can cause low power due to aeration of the fuel. If air enters the fuel, check the components for overtightening or undertightening.

i01007602

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

1. Stop the engine.

2. Turn off the start switch, or disconnect the battery (starting motor) when maintenance is performed on fuel filters.

3. Shut off the fuel tank supply valve to the engine.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

4. Unlock the fuel priming pump (if equipped). This relieves any residual pressure in the fuel system.

5. Remove the used fuel filter. Use a cloth, or use a container to catch excess fuel.

6. Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.

7. Apply clean diesel fuel to the new fuel filter gasket.

NOTICE
Do not fill the secondary fuel filter with fuel before installing. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

8. Install a new fuel filter, and tighten the fuel filter until the gasket contacts the base.

9. Tighten the fuel filter by hand according to the instructions that are shown on the fuel filter.

   Do not overtighten the fuel filter.

10. Lock the fuel priming pump (if equipped). Open the fuel tank supply valve.

11. If the engine stalls, refer to the Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section) for more information.

i02112513

Fuel System Water Separator - Drain

SMCS Code: 1263-543

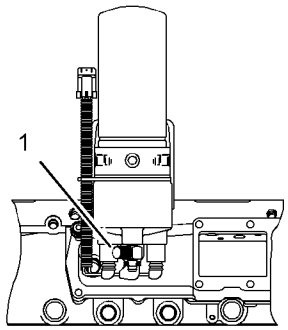
⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
The water separator is not a filter. It separates water from the fuel.

The engine should never be allowed to run with the water level in the separator more than 1/2 full or engine damage may result.

A water separator is recommended. The water separator should be installed between the fuel tank and the engine fuel inlet. Drain the water and sediment from the water separator on a daily basis.



g01076474

Illustration 36

(1) Drain

1. Open drain (1). Catch the draining water in a suitable container. Dispose of the water properly.

NOTICE
The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

2. Close drain (1).

i02436696

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A 2 micron filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, “Improving Fuel System Durablity”.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i01057362

Heat Exchanger - Inspect

SMCS Code: 1379-040

The interval for the maintenance of the tube and fin heat exchanger depends on the operating environment of the vessel and on the operating time. The sea water that is circulated through the heat exchanger and the amount of operating time of the vessel affects the following items:

- Cleanliness of the tubes of the heat exchanger
- Effectiveness of the heat exchanger system

Operating in water that contains silt, sediment, salt, algae, etc will adversely affect the heat exchanger system. In addition, intermittent use of the vessel will adversely affect the heat exchanger system.

The following items indicate that the heat exchanger may require cleaning:

- Increased coolant temperature
- Engine overheating
- Excessive pressure drop between the water inlet and the water outlet

An operator that is familiar with the normal operating temperature of the coolant can determine when the coolant temperature is out of the normal range. Inspection and maintenance of the heat exchanger are required if the engine is overheating.

Your Caterpillar dealer has the equipment and the trained personnel that are needed in order to measure the pressure drop across the heat exchanger.

The procedure for cleaning the heat exchanger is similar to the procedure that is used for cleaning the aftercooler core. Refer to the Operation and Maintenance Manual, “Aftercooler Core - Clean/Test” topic (Maintenance Section). For more information on servicing the heat exchanger, consult your Caterpillar dealer.

i02121526

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed

- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: Refer to the Specifications, SENR3130, “Torque Specifications” in order to locate the proper torques.

8. Refill the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap’s gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i01089872

Marine Transmission Oil Level - Check

SMCS Code: 3081-535

Check the marine transmission oil level according to the instructions that are provided by the OEM of the transmission or the OEM of the vessel.

For the lubrication requirements of the transmission, refer to the recommendations on the nameplate or the “Owner’s Manual” for the transmission.

Marine Transmission Operation, Maintenance, Warranty, and Parts Support

For information on maintenance and operation of the marine transmission, consult your Caterpillar dealer and/or the OEM dealer of the transmission.

All support for the warranty of the transmission will be the responsibility of the OEM. All parts support for the transmission will be the responsibility of the OEM. This parts support includes both the installation of parts and the resolution of any service problems.

i02378613

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used

- The operating conditions
- The results of the S·O·S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed from the hull, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Cylinder Head Assembly, Cylinder Packs, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime

- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Valve rotators
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Note: If the crankshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the crankshaft.

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core and Aftercooler Core

During an overhaul, Caterpillar Inc. recommends the removal of both the oil cooler core and the aftercooler core. Clean the oil cooler core and the aftercooler core. Then, pressure test both of these cores.

NOTICE
Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core and the aftercooler core.

1. Remove the oil cooler core and the aftercooler core.
2. Remove any debris from the oil cooler core and the aftercooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end. To remove debris from the aftercooler core, turn the aftercooler core upside-down.
3. Flush the oil cooler core and the aftercooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core and the aftercooler core.

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 14 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 14

Hydrosolv Liquid Cleaners[1]		
Part Number	**Description**	**Size**
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

(1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F).

4. Use steam to clean the oil cooler core and the aftercooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core and the aftercooler core. Remove any other trapped debris.

5. Wash the oil cooler core and the aftercooler core with hot, soapy water. Rinse the oil cooler core and the aftercooler core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the oil cooler core and the aftercooler core with compressed air. Direct the air in the reverse direction of the normal flow.

7. Inspect the components in order to ensure cleanliness. The oil cooler core and the aftercooler core should be pressure tested. Repair the oil cooler core and the aftercooler core, if necessary. Install the oil cooler core and the aftercooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level II) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i01411756

Turbocharger - Inspect/Clean

SMCS Code: 1052-571

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE
Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

   The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.

5. Inspect the bore of the turbine housing for corrosion.

6. Clean the turbocharger housing and clean the backing plate of the cartridge with standard shop solvents and a soft bristle brush.

7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i00073831

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE
For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE
Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped and tight. Check for leaks. Check the condition of all pipes.
- Check the marine transmission oil level. Refer to the OEM specification for the marine transmission or refer to the OEM specification for the vessel.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pumps and the installation of water pumps and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the ECM to the cylinder head ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or can not be calibrated.

i01057943

Water Pump - Inspect

SMCS Code: 1361-040; 1361

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump seal or the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

Note: Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

i02053417

Zinc Rods - Inspect/Replace

SMCS Code: 1388-040; 1388-510

Corrosion in sea water circuits can result in premature deterioration of cooling system components, leaks, and possible cooling system contamination. The corrosion may be caused by the lack of zinc rods in the sea water system.

Zinc rods are inserted in the sea water cooling system of the engine in order to help prevent the corrosive oxidation that is caused by sea water. The reaction of the zinc to the sea water causes the zinc rods to oxidize rather than the cooling system components. Rapid deterioration of zinc rods may indicate the presence of uncontrolled electrical currents from improperly installed electrical attachments or improperly grounded electrical attachments.

The zinc rods must be inspected at the proper intervals. The zinc rods must be replaced when deterioration occurs.

Inspect the Zinc Rods

The zinc rods are red for easy identification. Table 15 shows the locations of the zinc rods and the quantities of the zinc rod:

Table 15

Locations of the Zinc Rods	
Location	**Quantity**
Heat Exchanger	3
Transmission Oil Cooler(1)	2
Aftercooler	2

(1) Zinc rods will only be located in marine transmission oil coolers that are cooled with sea water.

1. Remove the zinc rod.
2. Inspect the zinc rod.

   Ensure that the zinc rod will remain effective until the next scheduled inspection.

   a. If the zinc rod has deteriorated excessively, install a new zinc rod.

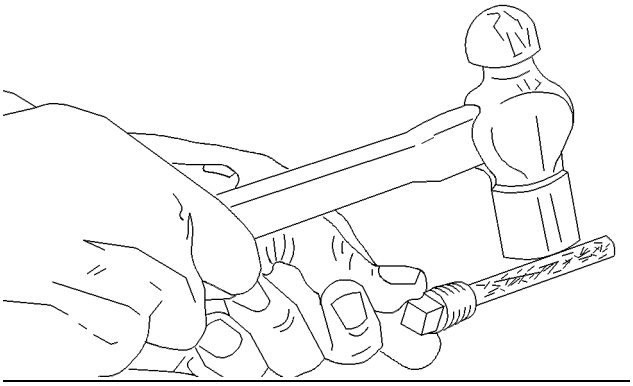


Illustration 37 g00481100

   b. Tap the zinc rod lightly with a hammer. If the zinc rod flakes, install a new zinc rod.

3. If the zinc rod will be reused, scrape the layer of oxidation from the zinc rod before installation. The layer of oxidation reduces the effectiveness of the zinc rod.

Replace the Zinc Rods

1. Unscrew the old zinc rod from the plug.

   If not enough material remains or the zinc rod has broken off, drill the old zinc rod from the plug.

2. Clean the plug.

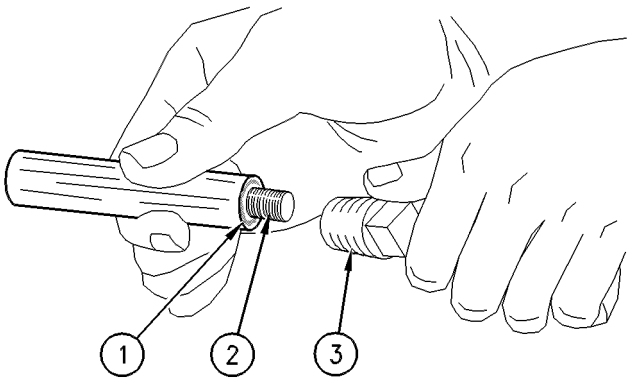


Illustration 38 g00480345

(1) Shoulder of the zinc rod
(2) Threads of the zinc rod
(3) External threads of the plug

Note: DO NOT apply adhesive or sealant to threads (2) of the zinc rod.

3. Apply 9S-3263 Thread Lock Compound to shoulder (1) of a new zinc rod. Apply the compound ONLY to the shoulder of the zinc rod. Install the zinc rod onto the plug.

4. Coat external threads (3) of the plug with 5P-3413 Pipe Sealant. Install the zinc rod. Refer to Specifications, SENR3130, “Torque Specifications”.